AMENDED SPECIFICATION

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PATENT SPECIFICATION

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NO DRAWINGS

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COMPLETE SPECIFICATION

Improvements in or relating to Tyres for Road Vehicles

We, NATIONAL RESEARCH DEVELOPMENT CORPORATION, a British Corporation, established by Statute, of 1, Tilney Street, London, W.1. do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to tyres for road vehicles.

It has been discovered that the forces resisting the motion of a resilient material, such as rubber, along a hard rough substantially flat surface which has been lubricated, such as a wet road surface, are principally those due to internal hysteresis losses arising from the deformation of the resilient material.

It has also been discovered that these hysteresis losses are higher the lower the modulus of elasticity of the resilient material, but as the hysteresis loss varies as $\left(\frac{1}{E}\right)^{\frac{1}{3}}$ (where E is the modulus of elasticity) it is not sensitive to changes in E which may be chosen on other grounds of suitability such as resistance to wear, structural rigidity, etc.

According to the invention a tyre for a road vehicle has at least its tread or outer road-contacting portion made of a natural or synthetic rubber or of a composition containing such a rubber, the rebound resilience (as hereinafter explained) of such rubber or composition being not greater than 40% over the temperature range from −10 to +50 degrees centigrade.

Deformation of the tyre material takes place when its surface is dragged over local asperities in a slippery road surface by forward sliding of a locked wheel or sideways skidding of a wheel whether locked or not. Each asperity in the road surface ploughs a groove in the tyre surface and, except where the asperity is so sharp that it penetrates the lubricating film and abrades the tyre surface, this groove is self-healing. In the case of a tyre material having extremely low hysteresis losses, the energy expended in deforming the tyre material as the said groove proceeds along the tyre surface, which may be described as the "input energy," is substantially all returned on the recovery of the tyre material at the trailing side of the asperity, and the resistance to skidding is low. In the case of a tyre material having high hysteresis losses however, the input energy is to a large extent dissipated by the internal friction of the tyre material and only a small part of it is returned. The resistance to skidding is then greatly increased.

To obtain a satisfactory amount of absorbed energy and therefore a significant resistance to skidding, the input energy must be relatively high and this calls for a tyre material which has a sufficiently low modulus of elasticity so that adequate deformation takes place when the surface of the tyre is dragged over the local asperities in the road surface.

As previously indicated however, the relationship between the modulus of elasticity of the tread material and resistance to skidding is not a critical one and indeed the modulus of elasticity of the normal tyre tread as hitherto used, is sufficient to satisfy this requirement of the invention. Furthermore, tyre tread materials suitable for the invention and which are also satisfactory for the purpose in other respects such as resistance to abrasion and structural rigidity and durability do not differ greatly in respect of their modulus of elasticity from normal tyre tread materials as hitherto used, so that it is not necessary to stipulate

a particular range of modulus of elasticity for use in the tread portions of tyres according to the invention.

There is no need for the whole of a tyre to be made of material of the type stated so long as there is a tread portion made of such material which is as deep as the extent of the permissible wear of the tyre, and there are advantages in confining the use of such material to the tread portions of the tyre, as hereinafter explained.

The term "rebound resilience" is defined in Section 22.5 of British Standard No. 903/1950. In Section 22.1 it is said that rebound resilience is normally measured on the pendulum type of instrument; one such instrument considered as standard in B.S. 903/1950 is the Lüpke pendulum. For the purposes of the interpretation of this specification rebound resilience values quoted in it are to be taken as the values obtainable using only the Lüpke pendulum as the measuring instrument.

The curve of rebound resilience versus temperature is of the same general form for a large number of natural and synthetic rubbers or compositions containing the same and is characterised by a relatively low rebound resilience at some intermediate temperature with rising rebound resilience at temperatures above and below this intermediate temperature. The position on the temperature scale of the minimum rebound resilience and the steepness of the rise at higher and lower temperatures varies considerably however as between one material and another.

It is important for the purposes of the invention that the rebound resilience should not rise beyond the acceptable maximum at any tyre temperature at which skidding is likely to occur.

At the lower end of the temperature scale, say 0° C and below, ice is likely to be found on the roads. If the ice is rough the tendency to skid will be comparable with that encountered on an unfrozen wet road. The lower end of the temeprature range over which the requisite low rebound resilience is to be maintained, has been chosen at −10° C. Bearing in mind that this is the temperature of the tyre tread and that the temperature of the road surface will be below this, it may be expected that the ice will be dry at still lower temperatures and dry ice will not exhibit the characteristics of a lubricated surface. At tyre temperatures between −10° C and approximately 0° C ice, if present on the roads, may be expected to be wet and it is necessary to point out that if the ice is smooth (so-called "black ice") and wet no benefit can be obtained from the invention which depends for its efficacy on the grooving of a skidding tyre by small asperities in the road surface.

At the upper end of the temperature scale some rise of the rebound resilience is inevitable and it is necessary to choose a limit for the purpose of defining the invention which gives a minimum useful improvement to the road-holding properties of the tyre. The upper limit chosen is +50° C and whilst it is not contended that tyres do not get hotter than this, it is nevertheless rare for skid-provoking conditions to be encountered at temperatures such that the tyre temperature exceeds +50° C since rain, the commonest cause of skidding, is rarely associated with high temperatures whereas large areas of road surface coated with oil, which might well be accompanied by high temperatures, will be encountered extremely rarely. It is of course possible that high temperatures will be associated with the melting of tar and similar substances forming part of the road material, but it is doubtful whether the invention can afford any assistance in such conditions since the surface asperities on which the invention relies for its efficacy, lose their anchorage in the road surface under such conditions and are likely to be carried along by the tyre.

The rebound resilience of a normal tyre material as hitherto used rises to at least 60 per cent at some point within the chosen temperature range of −10° C to +50° C and whilst it is difficult to state with certainty how much lower than this the rebound resilience must be maintained to give a significant improvement in skid resistance, it is believed that a maximum of 40 per cent rebound resilience should be stipulated as giving the minimum improvement which the driver or rider of the vehicle using the tyre in question could appreciate.

The preferred materials for use in the invention are certain synthetic rubbers, notably Butyl rubber. Certain synthetic rubbers of the Butadiene type, notably the Butadiene acrylonitrile type and of the Organic Polysulphide type are also suitable for the purposes of the invention.

It will generally be desirable to compound the basic rubber with additives, notably carbon black, to provide the other qualities required of a tyre such as structural strength, resistance to wear and fracture, adhesion to reinforcement materials, etc. The choice of such additives and the properties they can give to the material are matters within the knowledge of those skilled in the art and it is therefore unnecessary to specify them. It should be noted however that increasing the carbon black content of the composition tends to reduce the rebound resilience so that certain rubbers not otherwise suitable for the invention can be made suitable for the invention by compounding them with abnormally large proportions of carbon black, but there are limits to the extent to which this may be done because excessive amounts of carbon black adversely affect other important qualities required of a tyre tread material.

In the course of normal rolling heat is

generated as a result of gross deformations of the tyre and the use in a tyre of a material of low rebound resilience tends to increase this heat. There will also be some increase of the heat generated by reason of the small scale deformation of the tread surface by small scale road surface asperities to which the tyre tread surface is caused to conform under load in the course of normal rolling of the tyre. Both these factors also tend to increase the rolling resistance of the tyre, but the latter factor is believed to be so small as to be negligible in respect of both heat generation and rolling resistance.

Increase of rolling resistance and heat generation, arising from gross deformation of the tyre, should be minimised as far as possible. So far as heat generation is concerned, the most vulnerable parts of the tyre are its side walls, which also tend to suffer the greatest deformation. Overheating of the side walls of a tyre lead to early disintegration and failure of the tyre. It is therefore preferable to make the side walls of material having a relatively high rebound resilience for instance at least 60°, at least at some temperature within the range between -10 and $+50$ degrees centigrade and to confine the use of the low rebound resilience material to the tread portion of the tyre. When this is done two precautions must be taken; first, provision must be made to give a warning when the low rebound resilience material has worn away to the point at which the road contacting part of the tread consists of a substantial proportion of the relatively high rebound resilience material of which the remainder of the tyre is made; secondly, care must be taken in choice of the materials used, to secure adequate adhesion of the different materials. In the latter connection it should be noted that Butyl rubber does not readily adhere to some other natural or synthetic rubbers which would otherwise be suitable for the non-tread portions of the tyre, so that an intermediate layer possessing properties of good adhesion to both the tread and non-tread materials may be interposed. Such an intermediate layer, which may be thin, may have a colour different from that of the tread material and this will serve to give a warning when the tread is worn to the point at which the anti-skid properties of the tyre are about to be lost.

Where the materials chosen for the tread and non-tread portions of the tyre have good adhesion to one another, there is no need for an intermediate layer and the two materials should be of different colours to give the necessary warning when the tread is worn.

WHAT WE CLAIM IS:—

1. A tyre for a road vehicle of which at least the tread or outer road-contacting portion is made of a natural or synthetic rubber or of a composition containing such a rubber the rebound resilience of such rubber or composition being not greater than 40 per cent at any temperature within the range from -10 to $+50$ degrees centigrade.

2. A tyre as claimed in Claim 1 in which the rubber is, or the composition contains, a synthetic rubber.

3. A tyre as claimed in Claim 1 in which at least the tread portion is made of a composition containing natural rubber and carbon black.

4. A tyre as claimed in Claim 2 in which the synthetic rubber is Butyl rubber.

5. A tyre as claimed in Claim 2 in which the synthetic rubber is of the Butadiene type.

6. A tyre as claimed in Claim 5 in which the synthetic rubber is of the Butadiene-acrylonitrile type.

7. A tyre as claimed in Claim 2 in which the synthetic rubber is of the Organic polysulphide type.

8. A tyre as claimed in Claim 1 in which parts of the tyre other than the tread or outer-road contacting portion are made of a natural or synthetic rubber or of a composition containing such a rubber the rebound resilence of such rubber or composition being of the order of at least 60 per cent, at least at some temperature within the range from -10 to $+50$ degrees centigrade.

9. A tyre as claimed in Claim 8 in which the tread or outer-road contacting portion of the tyre, and the parts of the tyre there beneath, are of different colours.

10. A tyre as claimed in Claim 9 in which a thin layer of natural or synthetic rubber or of a composition containing such a rubber and having a colour different from that of the tread or outer road-contacting portion, is interposed between the tread or outer road-contacting portion and the remainder of the tyre.

11. A tyre as claimed in Claim 10 in which the said tread or outer road-contacting portion and the said remainder of the tyre are made of materials which do not readily adhere to one another and in which the said thin interposed layer is made of a material which readily adheres to each of two other materials.

G. A. BLOXAM,
Chartered Patent Agent,
Agent for the Applicants.

PROVISIONAL SPECIFICATION

Improvements in or relating to Tyres for Road Vehicles

We, NATIONAL RESEARCH DEVELOPMENT CORPORATION, a British Corporation established by Statute of 1, Tilney Street, London, W.1, do hereby declare this invention to be described in the following statement:—

This invention relates to tyres for road vehicles.

I have discovered that the frictional forces resisting the motion of a resilient material, such as rubber, along a hard rough substantially flat surface which has been lubricated, are principally those due to internal hysteresis losses arising from the deformation of the resilient material.

I have also discovered that these hysteresis losses are higher the lower the modulus of elasticity of the resilient material.

According to one aspect of the invention therefore, at least the outer or road contacting part of a tyre for a road vehicle is made of a natural or synthetic rubber possessing high hysteresis losses.

According to another aspect of the invention at least the outer or road contacting part of a tyre for a road vehicle is made of a natural or synthetic rubber having a low modulus of elasticity.

Deformation of the tyre material takes place when its surface is dragged over local asperities in a slippery road surface by forward sliding of a locked wheel or sideways skidding of a wheel whether locked or not. Each asperity in the road surface ploughs a groove in the tyre surface and, except where the asperity is so sharp that it penetrates the lubricating film and abrades the tyre surface, this groove is self-healing. In the case of a tyre material having extremely low hysteresis losses, the energy expended in deforming the tyre material as the said groove proceeds along the tyre surface, which may be described as the " input energy," is substantially all returned on the rebound of the tyre material at the trailing side of the asperity, and the frictional resistance to skidding is low. In the case of a tyre material having high hysteresis losses, however, the input energy is to a large extent dissipated by the internal friction of the tyre material and only a small part of it is returned. The frictional resistance to skidding is then greatly increased.

To obtain a large amount of absorbed energy and therefore a large frictional resistance to skidding, the input energy must be relatively high and this calls for a tyre material which has a low modulus of elasticity so that relatively large deformation takes place when the surface of the tyre is dragged over the local asperities in the road surface.

It is not essential that the whole of a tyre should be made of material of the type stated so long as there is a surface layer of such material which is as deep as the extent of the permissible wear of the tyre.

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